

CLAIMS

1. A high-frequency package comprising a high-frequency semiconductor; a multilayer dielectric substrate having the high-frequency semiconductor mounted on a surface-layer ground conductor; and an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein
- the multilayer dielectric substrate includes
- a first signal via configured to be connected to a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic shielding member;
- a second signal via arranged outside the electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;
- an internal-layer signal line configured to connect between the first signal via and the second signal via;
- an internal-layer ground conductor arranged around the first signal via, the second signal via, and the internal-layer signal line; and
- a plurality of ground vias arranged around the first signal via, the second signal via, and the internal-layer signal line, on the internal-layer ground conductor, wherein
- a resistance film is provided on at least one of an upper surface and a lower surface of the internal-layer signal line.
2. The high-frequency package according to claim 1, wherein

the resistance film is provided at a portion near the first signal via on the internal-layer signal line.

3. The high-frequency package according to claim 1,
5 wherein

the resistance film is provided at portion near the second signal via on the internal-layer signal line.

4. The high-frequency package according to claim 1,
10 wherein

the multilayer dielectric substrate further includes
a ground conductor formed on a bottom surface
thereof; and

a cavity formed on the bottom surface, and
15 configured to mount the high-frequency semiconductor
therein,

the first signal via is configured to be connected to
a conductor pad that is configured to be connected to the
bias-and-control-signal terminal of the high-frequency
20 semiconductor with a wire, and

the external terminal for a bias and control signal is
configured to be connected to an external substrate with a
wire.

25 5. The high-frequency package according to claim 1,
wherein

a distance between adjacent ground vias among the
ground vias is less than approximately a half of an
effective wavelength of a high-frequency signal used in the
30 high-frequency semiconductor.

6. A transmission/reception module comprising:
a high-frequency package including

a high-frequency semiconductor including
a transmission-system circuit configured to
transmit a frequency-modulated transmission wave;

5 a reception system circuit configured to
receive a reception wave reflected from a target; and
a bias-and-control-signal terminal;

a multilayer dielectric substrate including a
surface-layer ground conductor configured to mount the
high-frequency semiconductor, and

10 an electromagnetic shielding member configured to
cover a part of a surface layer of the multilayer
dielectric substrate and the high-frequency semiconductor,
wherein

the multilayer dielectric substrate includes
15 a first signal via configured to be
connected to the bias-and-control-signal terminal, and
arranged within a region corresponding to the
electromagnetic shielding member;

a second signal via arranged outside the
20 region, and configured to be connected to an external
terminal for a bias and control signal;

an internal-layer signal line configured to
connect between the first signal via and the second signal
via;

25 an internal-layer ground conductor arranged
around the first signal via, the second signal via, and the
internal-layer signal line; and

a plurality of ground vias arranged around
the first signal via, the second signal via, and the
30 internal-layer signal line, on the internal-layer ground
conductor, and

a resistance film is provided on at least one of
an upper surface and a lower surface of the internal-layer

signal line;

a waveguide terminal configured to input and output a transmission wave and a reception wave between the high-frequency package and the high-frequency semiconductor; and

5 an external substrate configured to supply a bias signal to the high-frequency semiconductor, to exchange a control signal with the high-frequency semiconductor, and to control to modulate a transmission wave output from the high-frequency semiconductor.

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7. A radar device comprising:

a transmission/reception module including

a high-frequency package that includes

a high-frequency semiconductor including

15 a transmission-system circuit

configured to transmit a frequency-modulated transmission wave;

a reception system circuit configured to receive a reception wave reflected from a target; and

20 a bias-and-control-signal terminal;

a multilayer dielectric substrate including a surface-layer ground conductor configured to mount the high-frequency semiconductor; and

25 an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

the multilayer dielectric substrate includes

30 a first signal via configured to be connected to the bias-and-control-signal terminal, and arranged within a region corresponding to the electromagnetic shielding member;

a second signal via arranged outside

the region, and configured to be connected to an external terminal for a bias and control signal;

an internal-layer signal line
configured to connect between the first signal via and the
5 second signal via;

an internal-layer ground conductor
arranged around the first signal via, the second signal via,
and the internal-layer signal line; and

a plurality of ground vias arranged
10 around the first signal via, the second signal via, and the
internal-layer signal line, on the internal-layer ground
conductor, and

a resistance film is provided on at least
one of an upper surface and a lower surface of the
15 internal-layer signal line;

a waveguide terminal configured to input and
output a transmission wave and a reception wave between the
high-frequency package and the high-frequency
semiconductor; and

20 an external substrate configured to supply a bias
signal to the high-frequency semiconductor, to exchange a
control signal with the high-frequency semiconductor, and
to control to modulate a transmission wave output from the
high-frequency semiconductor;

25 an antenna configured to transmit and receive high-
frequency signals that are input and output via the
waveguide terminal;

an electronic circuit configured to convert an output
from the reception system circuit into a low-frequency
30 signal; and

a signal processing substrate configured to calculate
a distance and a relative speed with respect to a target
based on the low-frequency signal obtained by conversion by

the electronic circuit.

8. A high-frequency package comprising:

a high-frequency semiconductor including a bias-and-control-signal terminal;

a multilayer dielectric substrate including a surface-layer ground conductor configured to mount the high-frequency semiconductor; and

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

the multilayer dielectric substrate includes

a first signal via configured to be connected to the bias-and-control-signal terminal, and arranged inside the electromagnetic shielding member;

a second signal via arranged outside the electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;

an internal-layer signal line configured to connect between the first signal via and the second signal via;

an internal-layer ground conductor arranged around the first signal via, the second signal via, and the internal-layer signal line; and

a plurality of ground vias arranged around the first signal via, the second signal via, and the internal-layer signal line, on the internal-layer ground conductor, wherein

a slot line having a length approximately a quarter of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor is provided on the

internal-layer signal line.

9. A high-frequency package comprising:

a high-frequency semiconductor;

5 a multilayer dielectric substrate including a surface-layer ground conductor configured to mount the high-frequency semiconductor; and

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

the multilayer dielectric substrate is configured to include

a first signal via configured to be connected to a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic shielding member;

a second signal via arranged outside the electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;

an internal-layer signal line configured to connect between the first signal via and the second signal via;

25 an internal-layer ground conductor arranged around the first signal via, the second signal via, and the internal-layer signal line; and

a plurality of ground vias arranged around the first signal via, the second signal via, and the internal-layer signal line, on the internal-layer ground conductor, wherein

30 a low-pass filter configured to suppress passage of a high-frequency signal used in the high-frequency

semiconductor is provided on the internal-layer signal line.

10. A high-frequency package comprising:

a high-frequency semiconductor;

5 a multilayer dielectric substrate including a surface-layer ground conductor configured to mount the high-frequency semiconductor, and an internal-layer ground conductor configured to be connected to the surface-layer ground conductor; and

10 an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

the multilayer dielectric substrate includes

15 a first signal via configured to be connected to a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic shielding member;

a second signal via arranged outside the
20 electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;

an internal-layer signal line configured to connect between the first signal via and the second signal
25 via;

a first ground via string arranged at a portion closer to the high-frequency semiconductor than the first signal via, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor; and

30 a second ground via string arranged between the first signal via and the second signal via, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor, wherein

a distance between the first ground via string and the second ground via string is less than a half of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor, and

5 a distance between adjacent ground vias in the first and the second ground via strings respectively is less than a half of the effective wavelength of the high-frequency signal used in the high-frequency semiconductor.

10 11. A high-frequency package comprising:

a high-frequency semiconductor;

a multilayer dielectric substrate including a cavity that includes a surface-layer ground conductor formed on a bottom surface of the cavity, the surface-layer ground
15 conductor configured to mount the high-frequency semiconductor, wherein a sidewall forming the cavity is non-grounded; and

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer
20 dielectric substrate and the high-frequency semiconductor, wherein

the multilayer dielectric substrate is configured to include

a first signal via configured to be connected to
25 a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic shielding member;

a second signal via arranged outside the electromagnetic shielding member, and configured to be
30 connected to an external terminal for a bias and control signal;

an internal-layer signal line configured to connect between the first signal via and the second signal

via;

a first ground via string arranged at a portion closer to the high-frequency semiconductor than the first signal via and close to the sidewall of the multilayer dielectric substrate forming the cavity, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor; and

a second ground via string arranged between the first signal via and the second signal via, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor, wherein

a distance between the first ground via string and the second ground via string is less than a half of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor, and

a distance between adjacent ground vias in the first and the second ground via strings respectively is less than a half of the effective wavelength of the high-frequency signal used in the high-frequency semiconductor.

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12. The high-frequency package according to claim 11, wherein

a part of each of the ground vias in the first ground via string is exposed to a sidewall of the multilayer dielectric substrate.

25

13. A high-frequency package comprising:

a high-frequency semiconductor;

a multilayer dielectric substrate including a cavity that includes a surface-layer ground conductor formed on a bottom surface of the cavity, the surface-layer ground conductor configured to mount the high-frequency semiconductor; and

30

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

5 the multilayer dielectric substrate is configured to include

 a first signal via configured to be connected to a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic
10 shielding member;

 a second signal via arranged outside the electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;

15 an internal-layer signal line configured to connect between the first signal via and the second signal via;

 a sidewall ground pattern formed on the sidewall of the multilayer dielectric substrate forming the cavity;
20 and

 a ground via string arranged between the first signal via and the second signal via, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor, wherein

25 a distance between the sidewall ground pattern and the ground via string is less than a half of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor, and

 a distance between adjacent ground vias in the ground
30 via string is less than a half of the effective wavelength of the high-frequency signal used in the high-frequency semiconductor.

14. A high-frequency package comprising:

a high-frequency semiconductor;

a multilayer dielectric substrate including a cavity that includes a surface-layer ground conductor formed on a bottom surface of the cavity, the surface-layer ground conductor configured to mount the high-frequency semiconductor, wherein a sidewall forming the cavity is non-grounded; and

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor;

a first signal via configured to be connected to a bias-and-control-signal terminal of the high-frequency semiconductor, and arranged inside the electromagnetic shielding member;

a second signal via arranged outside the electromagnetic shielding member, and configured to be connected to an external terminal for a bias and control signal;

an internal-layer signal line configured to connect between the first signal via and the second signal via; and

a ground via string arranged between the first signal via and the second signal via, and including a plurality of ground vias configured to be connected to the internal-layer ground conductor, wherein

a distance between the sidewall and the ground via string is less than a quarter of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor, and

a distance between adjacent ground vias in the ground via string is less than a half of the effective wavelength of a high-frequency signal used in the high-frequency semiconductor.

15. The high-frequency package according to claim 11,
wherein

an area in which a dielectric material is exposed is
5 formed at a portion on the surface of the multilayer
dielectric substrate, the portion between the
electromagnetic shielding member and the sidewall.

16. The high-frequency package according to claim 13,
10 wherein

an area in which a dielectric material is exposed is
formed at a portion on the surface of the multilayer
dielectric substrate, the portion between the
electromagnetic shielding member and the sidewall.

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17. The high-frequency package according to claim 14,
wherein

an area in which a dielectric material is exposed is
formed in at a portion on the surface of the multilayer
20 dielectric substrate, the portion between the
electromagnetic shielding member and the sidewall.

18. The high-frequency package according to claim 10,
wherein

25 the second ground via string or the ground via string
is arranged immediately below a portion at which the
electromagnetic shielding member contacts the multilayer
dielectric substrate.

30 19. The high-frequency package according to claim 8,
wherein

the first signal via is configured to be connected to
a conductor pad formed on the surface layer of the

multilayer dielectric substrate, and a part or the whole surrounding of the conductor pad is surrounded with the surface-layer ground conductor through an area at which a dielectric material is exposed.

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20. A high-frequency package comprising:

a high-frequency semiconductor including a ground terminal and a bias-and-control-signal terminal on a rear surface thereof;

10 a plurality of conductor pads configured to mount the high-frequency semiconductor by flip-chip bonding on a surface layer;

a multilayer dielectric substrate including an internal-layer ground conductor configured to be connected
15 to the ground terminal; and

an electromagnetic shielding member configured to cover a part of a surface layer of the multilayer dielectric substrate and the high-frequency semiconductor, wherein

20 the multilayer dielectric substrate includes

a plurality of signal vias configured to be connected to the bias-and-control-signal terminal of the high-frequency semiconductor;

an internal-layer signal line configured to
25 connect between the signal vias; and

a plurality of ground via strings configured to be connected to the internal-layer ground conductor, and to surround the signal vias, wherein

a distance between the ground via strings sandwiching
30 the signal vias is less than a half of an effective wavelength of a high-frequency signal used in the high-frequency semiconductor.

21. A transmission/reception module comprising:

the high-frequency package according to any one of claims 8, 9, 10, 11, 13, 14, and 20, the high-frequency semiconductor including

5 a transmission system circuit configured to irradiate a frequency-modulated high-frequency signal to a target; and

a reception system circuit configured to receive a reception signal reflected from the target;

10 a waveguide terminal configured to input and output a transmission signal and the reception signal between the high-frequency package and the high-frequency semiconductor; and

a control circuit configured to supply a bias signal
15 to the high-frequency semiconductor of the high-frequency package, to exchange a control signal with the high-frequency semiconductor, and to control to modulate a transmission wave output from the high-frequency semiconductor.

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22. A radio device comprising:

the transmission/reception module according to claim 21;

25 an antenna configured to transmit and receive high-frequency signals that are input and output via the waveguide terminal of the transmission/reception module;

an electronic circuit configured to convert an output from the reception system circuit of the high-frequency package into a low-frequency signal; and

30 a signal processing substrate configured to calculate a distance and a relative speed with respect to a target based on the low-frequency signal obtained by conversion by the electronic circuit.